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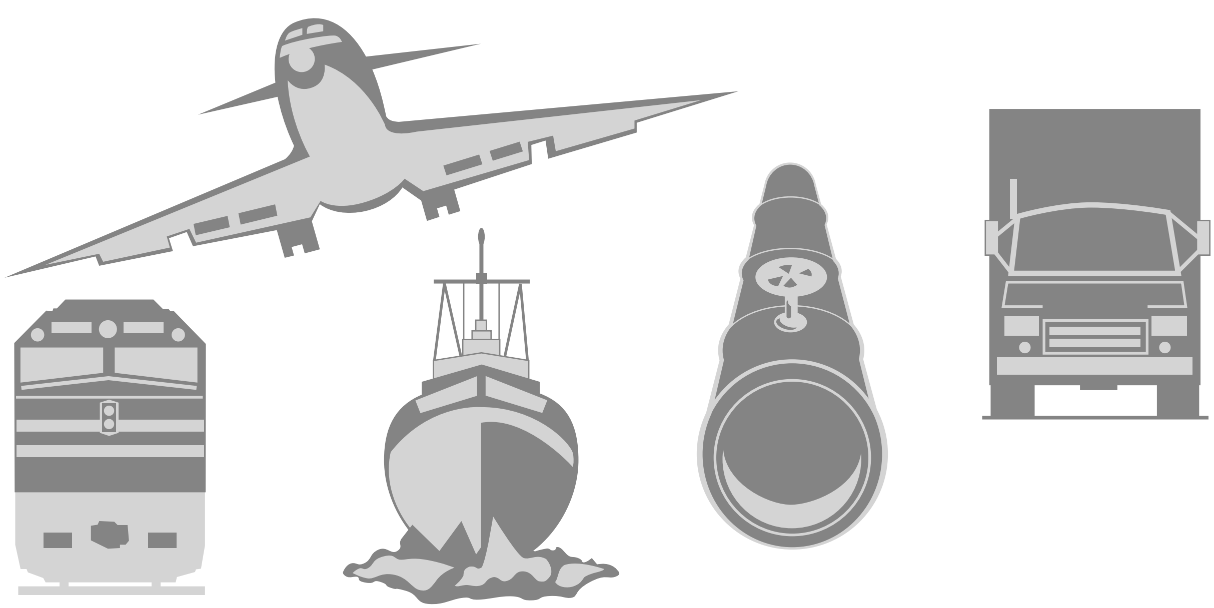
NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

SAFETY RECOMMENDATIONS

ADOPTED APRIL 2002



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: April 15, 2002

In reply refer to: A-02-06 and A-02-07

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On March 17, 2001, about 0708 eastern standard time, an Airbus Industrie A320-200, N357NW, manufacturer serial number 830, being operated by Northwest Airlines as flight 985, ran off the runway and onto terrain during a rejected takeoff at the Detroit Metropolitan Wayne County Airport, Detroit, Michigan. An emergency evacuation was performed. The captain, first officer, 4 flight attendants, and 145 passengers were not injured. Three passengers reported minor injuries that occurred during the emergency evacuation. The airplane sustained substantial damage. The 14 *Code of Federal Regulations* Part 121 flight was operating in instrument meteorological conditions, and an instrument flight rules flight plan had been filed. The flight was destined for Miami, Florida.

The flight crew reported that, during the takeoff roll at an airspeed of about 110 knots,[1] the nose of the airplane began to lift off the runway. In a postaccident interview, the captain stated that he continued the takeoff to rotation speed, but, because he believed the airplane pitch was uncontrollable, he initiated a rejected takeoff. The airplane then became airborne and climbed a few feet. As the airplane returned to the surface, its tail struck the runway. The airplane traveled about 700 feet off the end of the 8,500-foot runway and came to rest in muddy terrain.

During the investigation, National Transportation Safety Board staff determined that the airplane was loaded so that its center of gravity (CG), although within limits, was in the aft region of the permissible range. Further, the flight crew had incorrectly set the trim for the trimmable horizontal stabilizer (THS) at -1.7°UP (airplane nose up). This setting resulted in a pitch-up trim condition. The proper trim setting, 1.7°DN (airplane nose down), would have

[1] The computed rotation speed used for this flight was 143 knots.

resulted in a correct trim condition for the way the airplane was loaded. The improperly set trim caused the nose of the airplane to lift off the runway prematurely.[2]

The Safety Board is aware of a similar event that occurred in April 2000 when the crew of a Lufthansa A320-200 flight departing Brussels successfully aborted takeoff without incident after the nose began to lift off below its computed rotation speed. The postincident investigation conducted by the German Federal Bureau of Aircraft Accidents Investigation and Lufthansa revealed that the airplane was loaded with an aft CG, and that the flight crew had inadvertently set the THS trim at -2.2°UP rather than the correct setting of 2.0°DN.

Although the investigation into Northwest Airlines flight 985 accident is ongoing,[3] the Safety Board identified a safety issue regarding the procedures used by some airlines for setting the THS trim on the A320. The Board also identified a safety issue regarding inconsistent formats for presenting trim setting data to flight crews.

Airbus Industrie equips its A319, A320, and A321 airplanes with two index scales located adjacent to the THS trim wheel. (See figure 1.) One scale indicates the CG as a percentage of mean aerodynamic chord. In the accident airplane, the CG scale showed the values 10.5, 17, 20, 25, 30, 35, and 41.[4] The CG scale is not graduated and does not show intermediate values. The other scale indicates the number of degrees of THS deflection above or below zero (neutral), followed by “UP” or “DN” to indicate the corresponding pitch direction of the airplane. These values are 4DN, 3DN, 2DN, 1DN, 0, 1UP, 2UP, 3UP … 13UP, 13.5UP. Like the CG scale, the degree scale is not graduated and does not show intermediate values. Both the CG scale and the degree scale are fixed in relation to each other and move together when the trim is set.

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[2] Postaccident simulator flight tests have shown that, even with the improper trim setting, the airplane would have been controllable if the takeoff had continued. According to Airbus Industrie, the airplane is controllable on takeoff as long as the airplane’s CG is within the limits of the green band, and the trim, regardless of whether it is set incorrectly, is also within the green band. (The “green band” is the range of CG and trim positions approved for takeoff.)

[3] The description for this accident, CHI01FA104, can be found on the Safety Board’s Web site at <http://www.ntsb.gov>.

[4] Values shown on the CG scale differ depending on the type of engines installed on the airplane.

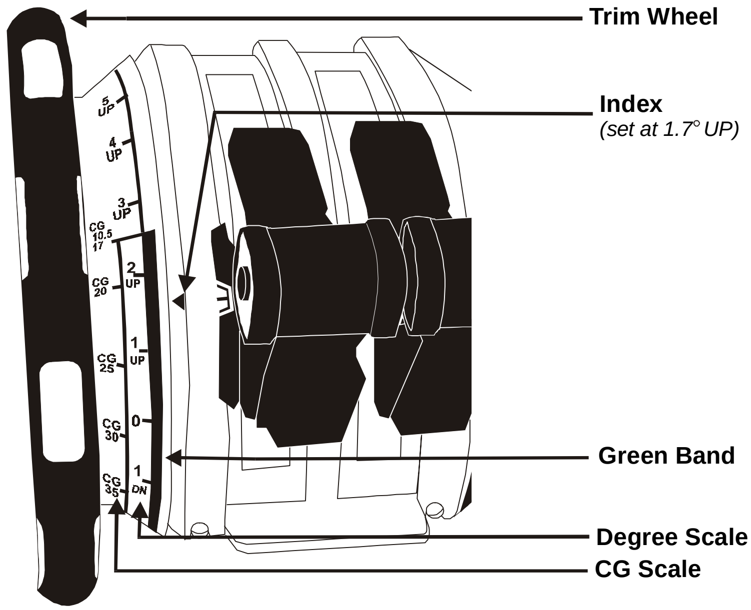

Figure 1. Airbus THS Trim Wheel Indicator Scales.

The trim setting (in degrees) is also shown on the flight control page of the electronic centralized aircraft monitoring (ECAM) display. This display, which correlates to the degree scale on the trim wheel, shows the trim in tenths of degrees followed by "UP" or "DN" to show the corresponding pitch direction of the airplane. On the ECAM display, pitch-up trim values are preceded by a minus sign ("-"), but pitch-down trim values are not preceded by a plus sign ("+"). The ECAM display for this accident would have shown the THS trim as "-1.7°UP." If the trim had been set correctly, it would have shown as "1.7°DN."

The A320 flight manual issued by Airbus Industrie specifies use of the CG scale for setting the THS trim. However, Northwest Airlines' Flight Operations Manual at the time of the accident called for the first officer to set the THS trim in degrees by turning the trim wheel while looking at the ECAM display.[5] The proper trim setting was provided to the crew on the load data sheet from the aircraft communication addressing and reporting system (ACARS) but was not followed by "UP" or "DN." In this case, the trim setting was given as "1.7." According to the manual, the captain was to cross-check the trim setting during the taxi checklist by looking at the "pitch trim wheel index." Northwest Airlines' pilots indicated that this cross-check was

[5] Because it displays the trim setting in tenths of degrees, the ECAM display provides a more precise way to cross-check the trim setting than the degree scale does.

supposed to be accomplished by the captain looking at the ECAM display (in degrees) and calling out the setting shown.[6] At the time of the Lufthansa event, Lufthansa's procedure for setting the trim was similar to Northwest's procedure.

After the accident, Northwest Airlines changed its procedures. Although the first officer continues to set the trim using degrees, the revised procedure requires the captain to cross-check the trim setting as indicated on the CG scale against the CG information contained in the load data sheet provided by ACARS.

Safety Board staff contacted three other major U.S. carriers that operate Airbus Industrie A320s regarding their procedures for setting the THS trim. One carrier reported using the CG scale to set the trim. The other two carriers reported using the degree scale without requiring the crew to cross-check the setting on the CG scale against the airplane's calculated CG.

The Safety Board is concerned that the procedure of using degrees to set and cross-check the THS trim setting has resulted in flight crews improperly setting the trim by using a minus (or UP) value when a plus (or DN) value should have been used. The Safety Board considers pilots of the two carriers who currently follow this procedure to be at risk for incorrectly setting the trim as did the pilots on Northwest flight 985 and the April 2000 Lufthansa flight. This confusion is possible because the degree scale shows some values twice: once to denote pitch up ("UP") and once to denote pitch down ("DN"). The CG scale, however, uses a consecutive series of unique, positive values, which eliminate the opportunity for such confusion.

The Safety Board is also concerned that the revised procedure currently used by Northwest Airlines to set the trim still calls for the first officer to use the degree scale initially in setting the trim. Although this procedure makes the captain responsible for catching any mistake made by the first officer by using a different scale to cross-check the trim setting, this procedure does not preclude the possibility of mistakes. The Safety Board concludes that a procedure that uses the CG scale to set and cross-check the trim setting will greatly reduce the potential for errors that are possible when using the degree scale to set the trim. Therefore, the Safety Board believes that the FAA should require operators of Airbus Industrie A319, A320, and A321 airplanes to set and cross-check the trim using CG values only.

In addition, the Safety Board is concerned about the inconsistent formats in which trim unit information is presented to Northwest flight crews and the possibility that other operators may also use inconsistent formats. As already noted, the degrees scale located next to the THS trim wheel shows trim values without a "+" or "-" sign, followed by "UP" or "DN" to indicate the corresponding pitch direction of the airplane. The ECAM also displays trim values to Northwest flight crews as "UP" or "DN" but also precedes trim values resulting in a nose-up pitch direction with a "-" sign. Finally, Northwest's ACARS load data sheet, which is the crew's initial source of trim unit information, precedes the trim value with a "-" sign for any setting that results in a nose-up pitch direction but does not display the corresponding "UP" or "DN" designations as appear on the trim wheel scale and ECAM display. The Board recognizes that a

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[6] The CVR indicated that the captain performed the cross-check by stating the trim setting as "negative 1.7."

procedure for setting and cross-checking trim that uses only CG information would not require flight crews to consult the ECAM or ACARS information regarding the trim setting in degrees. However, the Board notes that crews may nonetheless choose to consult that information to confirm that the CG setting selected is consistent with the THS position in degrees. Therefore, to avoid confusion, the Safety Board believes that the FAA should require operators of Airbus Industrie A319, A320, and A321 airplanes to ensure that the ECAM display and the ACARS load data sheet are configured so that they display THS trim unit information in a manner that is consistent with the display on the degree scale of the trim wheel indicator.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Require operators of Airbus Industrie A319, A320, and A321 airplanes to set and cross-check the trim using center of gravity trim values only. (A-02-06)
>
> Require operators of Airbus Industrie A319, A320, and A321 airplanes to ensure that the electronic centralized aircraft monitoring display and the aircraft communication addressing and reporting system load data sheet are configured so that they display trimmable horizontal stabilizer trim unit information in a manner that is consistent with the display on the degree scale of the trim wheel indicator. (A-02-07)

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

Original Signed

By: Marion C. Blakey
Chairman

National Transportation Safety Board
Washington, D.C. 20594

Safety Recommendation

Date: April 15, 2002

In reply refer to: A-02-08

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On March 29, 2001, about 1902 mountain standard time (MST),[1] a Gulfstream III, N303GA, operated by Avjet Corporation, collided with terrain about 2,400 feet short of runway 15 at Aspen-Pitkin County Airport, Sardy Field (ASE), Aspen, Colorado, while attempting to land. The three crewmembers and all 15 passengers were killed and the airplane was destroyed. The flight was operating under 14 *Code of Federal Regulations* (CFR) Part 135 as a charter flight from Los Angeles International Airport (LAX), Los Angeles, California, to ASE. Although the National Transportation Safety Board's investigation of this accident is ongoing, preliminary findings have revealed a safety issue that warrants the Federal Aviation Administration's (FAA) attention.

Background

N303GA departed LAX about 1611 Pacific standard time (1711 MST) on an instrument flight rules (IFR) flight plan and entered the Aspen terminal area about 1843. The cockpit voice recorder indicated that the flight crewmembers planned to conduct a visual approach to runway 15. However, as they descended toward the airport, clouds and snow showers increased, obscuring the field. Weather conditions at the time were reported as follows: wind 250° at 3 knots, visibility 10 miles, light snow, few clouds at 1,500 feet, broken cloud ceiling at 2,500 feet, and broken cloud ceiling at 5,000 feet. As N303GA continued its approach, ASE air traffic controllers provided arriving flight crews vectors for the airport's VOR/DME-C instrument approach procedure[2] and advised them that visibility north of the airport (along the flightpath of the approach) was reduced to 2 miles.

About 1845, the pilots of a corporate jet airplane ahead of N303GA executed a missed approach because they could not adequately identify the runway environment; air traffic control (ATC) broadcast a general advisory that a missed approach was executed. About 1858, the pilots

[1] Unless otherwise noted, all times in this letter are mountain standard time, based on a 24-hour clock.

[2] VOR/DME stands for very high frequency omnidirectional radio range/distance measuring equipment. The "C" in the approach title indicates that the approach does not include a straight-in landing because it does not meet the criteria for course alignment and/or the maximum descent gradient.

of another airplane ahead of N303GA also executed a missed approach because they could not adequately identify the runway environment. N303GA, which was following vectors to the VOR/DME-C approach course, initially descended in accordance with published altitude limits. However, radar data indicate that about 1900, the airplane descended below the published minimum altitude of 10,400 for the segment of the approach being executed. At 1900:48, when the airplane's altitude was about 9,900 feet, the Aspen tower local controller asked the pilot if he had the runway in sight, and the pilot replied that he did. According to the controller, less than 1 minute later, she observed the airplane emerging from a snow shower at a low altitude and not aligned with the runway.[3] Radar data show that, about this time, the airplane started maneuvering to the runway, entering a steep left turn for final runway alignment. While in this turn, the airplane contacted terrain to the right of the extended runway centerline at an elevation of 7,915 feet mean sea level (msl) and 2,400 feet short of runway 15. The elevation at the approach end of runway 15 is 7,674 feet msl.

Discussion

Official sunset[4] at the accident site on March 29 was about 1828, which was about 33 minutes before the accident; however, according to Safety Board calculations, the sun would have set below the mountainous terrain about 25 minutes before the official sunset time. The shadow for the ridge immediately to the west of the accident site would have crossed the site 79 minutes earlier than official sunset. All eyewitnesses to the accident reported that lighting conditions were very dark at the time of the crash; one of the controllers described conditions as "very dark" right before the accident. Because of these low light conditions, the pilot of N303GA most likely would not have been able to see the unlighted terrain while maneuvering to land. Although he told the controller that he had the runway in sight as he approached the airport, having the (lighted) runway in sight would not adequately ensure that he could also have seen the intervening unlighted terrain, especially given a higher-than-normal descent rate and his maneuvering to align with an upsloping runway.[5]

The Safety Board's investigation revealed that the accident pilot received a preflight briefing over the phone from the Federal Aviation Administration (FAA) Flight Safety Service. During this briefing, the pilot was informed that ASE's VOR/DME-C approach procedure was

[3] The instrument approach path is from the left side of the extended runway centerline and requires a left turn for final alignment with the runway.

[4] At sunset, the center of the sun is 0.8333° below the horizon and its top edge is at the horizon. According to the U.S. Naval Observatory, the times of sunrise and sunset cannot be computed precisely because "the actual times depend on unpredictable atmospheric conditions that affect the amount of refraction at the horizon. Thus, even under ideal conditions (for example, a clear sky at sea) the times computed for rise or set may be in error by a minute or more. Local topography (for example, mountains on the horizon) and the height of the observer can affect the times of rise or set even more."

[5] The approach end of runway 15 is at an elevation of 7,674 feet; its opposite end is at 7,820 feet, giving the runway an upward slope. Making an approach to an upsloping runway at night can aggravate a visual illusion known as the "black hole approach illusion." A pilot experiencing this illusion is not able to judge the runway's relationship to areas of unlighted terrain in the vicinity and flies a descent that is much more rapid than it should be, leading to CFIT or descent below intervening terrain. For more information, see R.F. Haines and C.L Flatau, *Night Flying*, 1st ed. (Blue Ridge Summit, PA: TAB Books, 1992) 105-111.

not authorized for use at night.[6] Title 14 CFR 1.1 defines the term “night” as “the time between the end of evening civil twilight and the beginning of morning civil twilight, as published in the American Air Almanac, converted to local time.” According to the U.S. Naval Observatory, morning civil twilight begins and evening civil twilight ends “when the center of the Sun is geometrically 6 degrees below the horizon.” In most of the continental United States, civil twilight roughly correlates to the 30-minute period before official sunrise and after official sunset.[7]

According to an evaluation prepared by an FAA flight inspection crew, ASE’s approach procedure is prohibited at night because there are numerous areas of unlighted rising terrain near the final approach course and the airport’s traffic pattern areas; when it is dark, pilots may not be able to safely maneuver to land while avoiding this unlighted terrain. According to the Flight Safety Foundation’s “Approach and Landing Accident Reduction CFIT [controlled flight into terrain]” checklist, limited lighting, a non-precision approach, and mountainous terrain are high-risk factors for CFIT.

Safety Board investigators determined that the combined effects of the surrounding terrain’s high elevation and weather conditions created twilight and nighttime conditions much earlier than would have occurred in non-mountainous terrain and in clear weather. Therefore, it became apparent during the Board’s investigation that the aeronautical definition of “night” does not adequately describe the conditions under which darkness exists in mountainous terrain and, therefore, use of this term may not adequately restrict potentially hazardous flight operations.

During civil twilight, the decrease in ambient illumination and resulting decrease in contrast between objects and the background scene diminishes a pilot’s ability to visually distinguish between terrain features and the sky and to visually detect unlighted obstacles. According to a United States Air Force study published in 1971,[8] visual detection of unlighted ground targets decreased by 39 percent under conditions that simulated the ambient light at sunrise or sunset and decreased by 75 percent under conditions that simulated the ambient light at the end of evening civil twilight or the beginning of morning civil twilight as compared to target detection capabilities under full sunlight conditions.

During evening civil twilight, the ambient light decreases by two orders of magnitude over a span of about 30 minutes. The ability of a pilot's eyes to fully adapt to the dark involves a gradual process that takes place over a similar time span. However, because the sky can be much brighter than terrain features during civil twilight, thereby exposing pilots to higher ambient light levels at altitude before descent, the process of dark adaptation can be delayed and its effectiveness, therefore, diminished. In addition, the rapid decreases in ambient illumination during approach and descent may be more pronounced in mountainous areas where terrain

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[6] The nighttime prohibition on ASE’s VOR/DME-C approach procedure was contained in Notice to Airmen 1/3034.

[7] H.W Leibowitz and D.A. Owens, “Can Normal Outdoor Activities Be Carried Out During Civil Twilight?,” *Applied Optics* Vol. 30 No. 24 (1991): 3501-3503.

[8] J. L. Porterfield, H.C. Self, S.A. Heckart, E. P. Hanavan, and D.F. McKechnie, *Airborne Visual Reconnaissance as a Function of Illumination Level,* AMRL Technical Report 71-9 (Wright-Patterson AFB, OH: U.S. Air Force Aerospace Medical Research Laboratory, DTIC No. 728 629, 1971).

features may rise well above the horizon, even further reducing ambient illumination levels at lower elevations. A pilot's ability to visually detect terrain features and unlighted obstacles can be further impeded during civil twilight as a result of an observed tendency among individuals to visually focus on a point nearer than the point of intended focus when in low illumination conditions.[9]

According to a 1991 review of research on visual factors associated with twilight conditions,[10] low visibility conditions will further reduce luminance levels and the contrast between objects and the surrounding scene. Therefore, the weather conditions at the time of the Aspen accident, which consisted of snow and cloud cover over the airport and approach course, likely further degraded the pilots' ability to detect unlighted terrain and obstacles.

The night prohibition on ASE's VOR/DME-C approach and similar restrictions at other airports recognize and attempt to address the hazards associated with operations over unlighted terrain in the dark by prohibiting night operations. However, the Safety Board is concerned that prohibitions aimed at preventing the hazards associated with flight operations in darkness do not take into account that conditions other than the official onset of "night" (such as high terrain, low visibility weather conditions, combined with human physiological factors) can significantly degrade the amount of ambient light available, creating twilight or nighttime conditions outside of the officially defined periods.

The Board notes that the FAA has recognized, in other contexts, that the threshold of a hazardous low light condition is not always readily defined and may not be adequately captured by the aeronautical definition of "night." For example, 14 CFR 91.157, "Special VFR [visual flight rules] weather minimums" states that special VFR operations may not be conducted between sunset and sunrise unless the pilot is IFR-qualified and the aircraft is IFR-equipped. However, visual transitions from instrument approaches (like that conducted by the pilot of N303GA) are often conducted in weather conditions similar to those in which special VFR applies (that is, visibility of 1 to 3 miles and clear of clouds), which makes the challenge of maintaining visual contact similar in both circumstances. In addition, guidance provided in FAA Order 7110.65, "Air Traffic Control," regarding light intensity settings for approach lights authorizes local facilities to deviate from the guidelines[11] "to meet local atmospheric, topographic, and twilight conditions." Similar exceptions to airfield and aircraft lighting are allowed in Alaska, where a low-light period is defined as that time during which "a prominent unlighted object cannot be seen from a distance of 3 statute miles or the sun is more than 6 degrees below the horizon."

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[9] H.W. Leibowitz and D.A. Owens, "Night Myopia and the Intermediate Dark Focus of Accomodation.," *Journal of the Optical Society of America*, Vol. 65, No. 10 (1975): 1121-1128.

[10] Leibowitz and Owens, *Applied Optics* Vol. 30 No. 24 (1991): 3501-3503.

[11] Paragraph 3-4-5 in the Order provides the following guidance for approach light settings at night: Step 1 when visibility is greater than 3 miles; Step 2 when visibility is 1 to 3 miles inclusive; Step 3 when visibility is less than 1 mile (and/or 6,000 feet or less of the runway visual range [RVR] on the runway served by the approach light system and RVR); and Steps 4 and 5 when requested.

To summarize, the following factors contribute to a diminished capability among pilots to visually detect unlighted terrain and obstacles during civil twilight and during other low-visibility periods outside official "nighttime":

- high local terrain that reduces ambient light levels and reduces visual contrast between objects in the visual scene;
- low visibility conditions that further reduce ambient light levels and visual contrast between objects;
- rapid changes in ambient light levels during approach and descent that may occur more quickly than the time needed to adequately adapt to the dark; and
- a tendency to visually focus on a point nearer than the point of intended focus when in low illumination conditions.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Revise any restrictions and prohibitions that currently reference or address "night" or "nighttime" flight operations in mountainous terrain so that those restrictions and prohibitions account for the entire period of insufficient ambient light conditions, and ensure that it is clear to flight crews when such restrictions and prohibitions apply. (A-02-08)

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

Original Signed

By: Marion C. Blakey
Chairman

National Transportation Safety Board
Washington, D.C. 20594

Safety Recommendation

Date: April 16, 2002

In reply to refer to: R-02-13

Honorable Allan Rutter
Administrator
Federal Railroad Administration
1120 Vermont Avenue, N.W.
Washington, D.C. 20590

On Saturday, May 27, 2000, about 11:48 a.m., 33 of the 113 cars making up eastbound Union Pacific Railroad (UP) train QFPLI-26 derailed near Eunice, Louisiana. Of the derailed cars, 15 contained hazardous materials and 2 contained hazardous materials residue. The derailment resulted in a release of hazardous materials with explosions and fire. About 3,500 people were evacuated from the surrounding area, which included some of the business area of Eunice. No one was injured during the derailment of the train or the subsequent release of hazardous materials. Total damages exceeded $35 million.[1]

The National Transportation Safety Board determined that the probable cause of the May 27, 2000, derailment of UP train QFPLI-26 was the failure of a set of joint bars that had remained in service with undetected and uncorrected defects because of the UP's ineffective track inspection procedures and inadequate management oversight.

During wreck-clearing operations, a rail with pieces of two broken joint bars attached to its east end was found. The following day, investigators located a similar rail with broken pieces of joint bars attached. Metallurgists at the site indicated that the two pairs of broken joint bars matched, which was later reaffirmed by a closer examination at the Safety Board's Materials Laboratory.

Investigators were more confident that the broken pair of joint bars had played a role in the derailment after observing that the top corner of the end face of the rail exhibited visible evidence of having been deformed by the impact of wheels moving over the top corner of the rail end. This is significant in that it demonstrates that the separated rail and joint bars had, for a time, remained in place while the wheels of a moving train passed over them. Such damage would not have been present if the joint bars had broken as a result of forces generated during the derailment.

[1] For more information, see National Transportation Safety Board, *Derailment of Union Pacific Railroad Train QFPLI-26 at Eunice, Louisiana, May 27, 2000,* Railroad Accident Report NTSB/RAR-02/03 (Washington, D.C.: NTSB, 2002).

Based on the engineer's statements, on the physical evidence exhibited by the broken joint bars and the damage to the end face of the rail that is consistent with wheel impact, and on the laboratory examination of the joint bars, the Safety Board concluded that the joint bars found at the point of the derailment had broken before the arrival of the accident train, which allowed the rail to become misaligned.

Investigators found that in the 5 months before the derailment, UP track inspectors had detected and replaced 128 defective joint bars. However, after the derailment, various walking inspections of the entire 44-mile section of jointed rail revealed 403 defective joint bars, indicating that regular track inspections had resulted in a significant number of defective joint bars remaining undetected.

As evidenced by the numerous joint bars that were found with fatigue cracks of varying lengths, a joint bar with a fatigue crack can remain in service for some time before failing completely. And although fatigue crack growth rates will vary depending on the type and frequency of forces exerted upon the joint bars, a fatigue crack, once initiated, can be expected to grow until it causes complete failure of the bar. Laboratory examination of the pair of broken joint bars found at the derailment site revealed that the fractures in those bars resulted from fatigue cracks, and while it cannot be determined when the cracks were initiated, they were certainly evident in the bars for some time before the bars failed in this accident. The Safety Board concluded that the UP track inspection procedures in use before the derailment were inadequate in that inspectors identified only a small proportion of the cracked or broken joint bars on the subdivision, with the result that defective joint bars that should have been replaced were allowed to remain in service.

In addition to the defective joint bars, investigators became aware of defective switch ties that were itemized on track inspection reports 6 weeks before the derailment, on March 11, April 7, and April 15. These switch ties remained in service, notwithstanding the six inspections per week for the 6-week period between April 15 and the derailment on May 27. The Federal Railroad Administration (FRA) chief inspector also located areas of defective crossties and joint bolt defects.

After the derailment, a thorough inspection of the jointed rail territory revealed track conditions that did not meet the requirements of class 3 track, and these conditions had likely existed for some time. As noted earlier, the inspection method used by UP track inspectors was inadequate to detect the significant number of cracked or broken joint bars in the inspection area, and Federal rules require that such defective bars be replaced if the track is to maintain its class 3 classification and be approved for 40 mph operations. Therefore, the Safety Board concluded that had the track of the Beaumont Subdivision been properly assessed, trains would not have been permitted to operate at a speed of 40 mph until appropriate repairs were made.

The FRA's records for the 5 years preceding the accident document a history of weak tie conditions and cracked joint bars in the jointed rail section of the Beaumont Subdivision. During a walking inspection in 1996, the FRA discovered 36 broken joint bars and identified areas with weak crossties. FRA inspectors inspected the track in January 1999 and discovered areas with insufficient crossties and defective joint bars. An inspector returned for a follow-up inspection in

March 1999 and found that the situation had been corrected; however, he found defective tie conditions at 11 locations and 2 cracked joint bars.

Although the FRA did not conduct a regular track inspection on the Beaumont Subdivision in the 13 months before the derailment, it did do a track geometry car inspection 47 days before the derailment. The track geometry car did not detect an unusual amount of poor track surface or alignment. The car did not, and was not designed to, detect track component defects—such as fatigue cracks in joint bars or defective crossties—that did not affect track geometry.

The Safety Board notes that hazardous materials can be expected to traverse most mainline rail routes; however, certain lines, such as the Beaumont Subdivision, are known to support a high volume of hazardous materials. In fact, train QFPLI-26 was designated a "key train" because of the amount and types of hazardous materials it was transporting. Further, according to the UP, the route from Freeport, Texas, to Livonia, Louisiana, is a "key route." The Association of American Railroads (AAR) defines "key route" as follows:

> Any track with a combination of 10,000 car loads or intermodal portable tank loads of hazardous materials, or a combination of 4,000 car loadings of PIH (Hazard zone A or B), flammable gas, Class 1.1 or 1.2 explosives (Class A), and environmentally sensitive chemicals, over a period of one year.

In its Circular OT-55, *Recommended Railroad Operating Practices for Transportation of Hazardous Materials*, the AAR states:

> Main Track on 'Key Routes' must be inspected by rail defect detection and track geometry inspection cars or any equivalent level of inspection no less that two times each year; and sidings must be similarly inspected no less than one time each year.

Because the inspections conducted by UP and FRA inspectors using special cars designed to detect internal rail defects or variances in track geometry did not and could not identify cracks or breaks in joint bars that did not affect track geometry, the Safety Board concluded that inspections of jointed rail using rail defect detection or track geometry cars are inadequate to identify the types of joint bar defects that led to this accident. As a result, the Safety Board has made the following safety recommendation to the AAR:

> <u>R-02-15</u>
> Revise the guidance in your Circular No. OT-55, *Recommended Railroad Operating Practices for Transportation of Hazardous Materials*, to recommend that all key routes be subjected to periodic track inspections that will identify cracks or breaks in joint bars.

The FRA had inspected Beaumont Subdivision track in 1999 because the military was planning a shipment of napalm. But as a key route, this track routinely carries other, possibly equally hazardous, materials that can constitute a serious risk to the public if the track does not comply with the Federal track safety standards. The Safety Board concluded that the frequency and type of track inspections routinely performed by the FRA on the Beaumont Subdivision were inappropriate given the fact that this was a key route that carried large volumes of hazardous materials.

Therefore, the National Transportation Safety Board makes the following safety recommendation to the Federal Railroad Administration:

> Modify your track inspection program to incorporate the volume of hazardous materials shipments made over the tracks in determining the frequency and type of track inspections. (R-02-13)

The Safety Board also issued safety recommendations to the Union Pacific Railroad and the Association of American Railroads.

Please refer to Safety Recommendation R-02-13 in your reply. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

Original Signed

By: Marion C. Blakey
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: April 16, 2002

In reply refer to: R-02-14

Mr. Richard K. Davidson
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1416 Dodge Street
Omaha, Nebraska 68179

The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendation in this letter. The Safety Board is vitally interested in this recommendation because it is designed to prevent accidents and save lives.

This recommendation addresses track conditions on the Union Pacific Railroad's (UP's) Beaumont Subdivision and the effectiveness of the UP's track inspection activities, including management oversight. The recommendation is derived from the Safety Board's investigation of the May 27, 2000, derailment of UP train QFPLI-26 at Eunice, Louisiana, and is consistent with the evidence we found and the analysis we performed. As a result of this investigation, the Safety Board has issued three safety recommendations, one of which is addressed to the UP. Information supporting this recommendation is discussed below. The Safety Board would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendation.

On Saturday, May 27, 2000, about 11:48 a.m., 33 of the 113 cars making up eastbound UP train QFPLI-26 derailed near Eunice, Louisiana. Of the derailed cars, 15 contained hazardous materials and 2 contained hazardous materials residue. The derailment resulted in a release of hazardous materials with explosions and fire. About 3,500 people were evacuated from the surrounding area, which included some of the business area of Eunice. No one was injured during the derailment of the train or the subsequent release of hazardous materials. Total damages exceeded $35 million.[1]

The National Transportation Safety Board determined that the probable cause of the May 27, 2000, derailment of UP train QFPLI-26 was the failure of a set of joint bars that had

[1] For more information, see National Transportation Safety Board, *Derailment of Union Pacific Railroad Train QFPLI-26 at Eunice, Louisiana, May 27, 2000,* Railroad Accident Report NTSB/RAR-02/03 (Washington, D.C.: NTSB, 2002).

remained in service with undetected and uncorrected defects because of the UP's ineffective track inspection procedures and inadequate management oversight.

During wreck-clearing operations, a rail with pieces of two broken joint bars attached to its east end was found. The following day, investigators located a similar rail with broken pieces of joint bars attached. Metallurgists at the site indicated that the two pairs of broken joint bars matched, which was later reaffirmed by a closer examination at the Safety Board's Materials Laboratory.

Investigators were more confident that the broken pair of joint bars had played a role in the derailment after observing that the top corner of the end face of the rail exhibited visible evidence of having been deformed by the impact of wheels moving over the top corner of the rail end. This is significant in that it demonstrates that the separated rail and joint bars had, for a time, remained in place while the wheels of a moving train passed over them. Such damage would not have been present if the joint bars had broken as a result of forces generated during the derailment.

Based on the engineer's statements, on the physical evidence exhibited by the broken joint bars and the damage to the end face of the rail that is consistent with wheel impact, and on the laboratory examination of the joint bars, the Safety Board concluded that the joint bars found at the point of the derailment had broken before the arrival of the accident train, which allowed the rail to become misaligned.

The UP track inspector explained that his inspection territory consisted of about 84 miles of the Beaumont Subdivision, from milepost (MP) 507 to MP 590.75, which he inspects using a Hy-Rail vehicle. The track inspector stated that he did the track inspections at speeds between 20 and 25 mph on continuous welded rail track and between 15 and 20 mph on jointed rail.

On the day after the derailment, Safety Board investigators inspected the track west of the derailment site with a Hy-Rail vehicle. A walking inspection was conducted east of the derailment site. During the walking inspection, joint bars with visible vertical cracks were found. Subsequent inspections during the following days identified additional cracked and broken joint bars on either side of the derailment area.

The investigators noted that the cracks they found in the joint bars were not visible to a track inspector using a Hy-Rail vehicle. An inspector driving such a vehicle across a rail joint could see only the tops of the two joint bars on the driver's side and the joint bar on the gage side of the track on the passenger side. The joint bar on the field side of the track on the passenger side of the vehicle was not visible.

The vehicle the track inspector used during his track inspections was a 1996 Chevrolet 1-ton super-cab pickup truck with Fairmont Hy-Rail equipment. Although forward visibility will vary somewhat depending on the seat adjustment and the height of the driver, an inspector in the driver's seat cannot see a track component that is less than about 28 feet in front of the vehicle. With a newer model of pickup truck (having a shorter hood), the track component is not visible unless it is at least 19.5 feet in front of the operator. With a flat-front inspection vehicle, an operator can see a track component at a distance of about 9.5 feet.

Investigators found that in the 5 months before the derailment, UP track inspectors had detected and replaced 128 defective joint bars. However, after the derailment, various walking inspections of the entire 44-mile section of jointed rail revealed 403 defective joint bars, indicating that regular track inspections had resulted in a significant number of defective joint bars remaining undetected.

Federal Railroad Administration (FRA) records of track inspections of the Beaumont Subdivision for the 5 years preceding the accident document a history of weak tie conditions and cracked joint bars in the jointed rail section of the subdivision. Ideally, FRA track inspections should echo the railroad's own track inspections. During a walking inspection in 1996, the FRA discovered 36 broken joint bars and identified areas with weak crossties. Again in 1997 and 1998, FRA inspections revealed defective joint bars. FRA inspectors inspected the track in January 1999 and discovered areas with insufficient crossties and defective joint bars. An inspector returned for a follow-up inspection in March 1999 and found that the situation had been corrected; however, he found defective tie conditions at 11 locations and 2 cracked joint bars.

As evidenced by the numerous joint bars that were found with fatigue cracks of varying lengths, a joint bar with a fatigue crack can remain in service for some time before failing completely. And although fatigue crack growth rates will vary depending on the type and frequency of forces exerted upon the joint bars, a fatigue crack, once initiated, can be expected to grow until it causes complete failure of the bar. Laboratory examination of the pair of broken joint bars found at the derailment site revealed that the fractures in those bars resulted from fatigue cracks, and while it cannot be determined when the cracks were initiated, they were certainly evident in the bars for some time before the bars failed in this accident. The Safety Board concluded that the UP track inspection procedures in use before the derailment were inadequate in that inspectors identified only a small proportion of the cracked or broken joint bars on the subdivision, with the result that defective joint bars that should have been replaced were allowed to remain in service.

In addition to the defective joint bars, investigators became aware of defective switch ties that were itemized on track inspection reports 6 weeks before the derailment, on March 11, April 7, and April 15. These switch ties remained in service, notwithstanding the six inspections per week for the 6-week period between April 15 and the derailment on May 27.

After the derailment, a thorough inspection of the jointed rail territory revealed track conditions that did not meet the requirements of class 3 track, and these conditions had likely existed for some time. As noted earlier, the inspection method used by UP track inspectors was inadequate to detect the significant number of cracked or broken joint bars in the inspection area, and Federal rules require that such defective bars be replaced if the track is to maintain its class 3 classification and be approved for 40 mph operations. Therefore, the Safety Board concluded that had the track of the Beaumont Subdivision been properly assessed, trains would not have been permitted to operate at a speed of 40 mph until appropriate repairs were made.

Despite inspection methods that were generally inadequate to identify all defective joint bars, enough defects were noted to demonstrate that defective joint bars were a frequent and persistent problem on the subdivision. For the 2-month period before the derailment, there were numerous records of defective joint bars and of joint bars with missing or defective bolts. For example, in the week before the derailment, the UP track inspector found three rail joints at which both joint bars had broken, which is the same type of failure that was found at the location of the derailment.

The manager of track maintenance told investigators that he reviewed the track inspection reports at the end of each month, but he did not scrutinize them. Had he done so, he may have noted the recurring problems associated with joint bars. The three broken pairs of joint bars that were found and replaced just days before the derailment should have alerted management to the potential for other occurrences of total joint bar failure. This is especially true given that, as noted above, joint bars normally provide evidence, such as cracks, of impending failure before complete failure actually occurs. Managers who reviewed the track reports closely would have been aware that track inspections were not always identifying weakened joint bars in time to prevent future failures and potential risk to trains. The Safety Board therefore concluded that if UP management had thoroughly examined track inspection reports, they may have determined that track inspections were not identifying joint bar defects that could, over time, lead to complete joint bar failure.

The National Transportation Safety Board therefore makes the following safety recommendation to the Union Pacific Railroad:

> Change your track inspection programs to ensure that managers are making use of all available information about track conditions, including railroad and Federal Railroad Administration track inspection reports, to identify trends or problem areas and to monitor the effectiveness of daily track inspections. (R-02-14)

The Safety Board also issued safety recommendations to the Federal Railroad Administration and the Association of American Railroads. In your response to the recommendation in this letter, please refer to Safety Recommendation R-02-14. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

Original Signed

By: Marion C. Blakey
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: April 16, 2002

In reply refer to: R-02-15

Mr. Edward Hamberger
President
Association of American Railroads
50 F Street, N.W.
Washington, D.C. 20001

The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendation in this letter. The Safety Board is vitally interested in this recommendation because it is designed to prevent accidents and save lives.

This recommendation is derived from the Safety Board's investigation of the May 27, 2000, derailment of Union Pacific Railroad (UP) train QFPLI-26 at Eunice, Louisiana, and is consistent with the evidence we found and the analysis we performed. As a result of this investigation, the Safety Board has issued three safety recommendations, one of which is addressed to the Association of American Railroads (AAR). Information supporting this recommendation is discussed below. The Safety Board would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendation.

On Saturday, May 27, 2000, about 11:48 a.m., 33 of the 113 cars making up eastbound UP train QFPLI-26 derailed near Eunice, Louisiana. Of the derailed cars, 15 contained hazardous materials and 2 contained hazardous materials residue. The derailment resulted in a release of hazardous materials with explosions and fire. About 3,500 people were evacuated from the surrounding area, which included some of the business area of Eunice. No one was injured during the derailment of the train or the subsequent release of hazardous materials. Total damages exceeded $35 million.[1]

The National Transportation Safety Board determined that the probable cause of the May 27, 2000, derailment of UP train QFPLI-26 was the failure of a set of joint bars that had remained in service with undetected and uncorrected defects because of the UP's ineffective track inspection procedures and inadequate management oversight.

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Based on the engineer's statements, on the physical evidence exhibited by the broken joint bars and the damage to the end face of the rail that is consistent with wheel impact, and on the laboratory examination of the joint bars, the Safety Board concluded that the joint bars found at the point of the derailment had broken before the arrival of the accident train, which allowed the rail to become misaligned.

Observing track from a moving inspection vehicle is the most common method of inspecting track, and this is the method the UP used; however, this method is inadequate for detecting defective joint bars. From the operator's position in the vehicle, the inspector cannot see any part of the outside joint bar on the passenger side of the vehicle and can see only the tops of the two joint bars on the operator's side. Even those joint bars that can be partially seen by the inspector may have small fractures that are extremely difficult, if not impossible, to see from a moving vehicle.

The UP chief engineer told investigators that on the Beaumont Subdivision, the rail was inspected for internal defects twice a year. The UP had done the last rail inspection for internal defects on the main track with its DC-9 test car on April 11, 2000, and had found five rail defects. According to its summary report of rail detector car results on the Beaumont Subdivision for 1999, the UP, using rail test cars, had conducted internal rail inspections on April 20, July 22, and October 12. On February 2, 2000, the UP did a track geometry inspection between milepost (MP) 556 and MP 584 (the derailment occurred near MP 567) and did not find any track geometry defects within the area of the derailment.

Investigators found that in the 5 months before the derailment, UP track inspectors had detected and replaced 128 defective joint bars. However, after the derailment, various walking inspections of the entire 44-mile section of jointed rail revealed 403 defective joint bars, indicating that regular track inspections had resulted in a significant number of defective joint bars remaining undetected.

As evidenced by the numerous joint bars that were found with fatigue cracks of varying lengths, a joint bar with a fatigue crack can remain in service for some time before failing completely. And although fatigue crack growth rates will vary depending on the type and frequency of forces exerted upon the joint bars, a fatigue crack, once initiated, can be expected to grow until it causes complete failure of the bar. Laboratory examination of the pair of broken joint bars found at the derailment site revealed that the fractures in those bars resulted from fatigue cracks, and while it cannot be determined when the cracks were initiated, they were certainly evident in the bars for some time before the bars failed in this accident. The Safety Board concluded that the UP track inspection procedures in use before the derailment were inadequate in that inspectors identified only a small proportion of the cracked or broken joint bars on the subdivision, with the result that defective joint bars that should have been replaced were allowed to remain in service.

After the derailment, the UP added to the *Union Pacific Engineering Track Maintenance Field Manual* the requirement that jointed rail territory that carries more than 10 million gross tons and is class 2 track or higher be subject to quarterly walking inspections. Included in the manual is an explanation of the proper method of inspecting rail joint bars and the requirement that the dates and locations of walking inspections be recorded on the track inspection reports.

Although the Federal Railroad Administration (FRA) did not conduct a regular track inspection on the Beaumont Subdivision in the 13 months before the derailment, it did do a track geometry car inspection 47 days before the derailment. The track geometry car did not detect an unusual amount of poor track surface or alignment. The car did not, and was not designed to, detect track component defects—such as fatigue cracks in joint bars or defective crossties—that did not affect track geometry.

UP officials stated that the route from Freeport, Texas, to Livonia, Louisiana, was designated a key route because of the types and volumes of hazardous materials carried over it. The AAR, in its Circular No. OT-55-B, *Recommended Railroad Operating Practices for Transportation of Hazardous Materials*, states that mainline track on key routes "must be inspected by rail defect detection and track geometry inspection cars or any equivalent level of inspection no less than two times each year."

As noted earlier, inspections conducted by UP and FRA inspectors using special cars designed to detect internal rail defects or variances in track geometry did not and could not identify cracks or breaks in joint bars that did not affect track geometry. The Safety Board concluded that inspections of jointed rail using rail defect detection or track geometry cars are inadequate to identify the types of joint bar defects that led to this accident.

The National Transportation Safety Board therefore makes the following safety recommendation to the Association of American Railroads:

> Revise the guidance in your Circular No. OT-55, *Recommended Railroad Operating Practices for Transportation of Hazardous Materials*, to recommend that all key routes be subjected to periodic track inspections that will identify cracks or breaks in joint bars. (R-02-15)

The Safety Board also issued safety recommendations to the Federal Railroad Administration and the Union Pacific Railroad. In your response to the recommendation in this letter, please refer to Safety Recommendation R-02-15. If you need additional information, you may call (202) 314-6607.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

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